# *Appendix C – Site Selection Process*

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# 1 NASA FEASIBILITY STUDY

The process of screening potential sites for U.S. commercial spaceports began with the White House Space Policy Statement of 1988. The initial study examining the feasibility of the development of a commercial spaceport in the southwestern U.S. was commissioned under a NASA Grant in 1992. The grant was awarded to the New Mexico State University (NMSU), and administered by the NMSU Physical Science Laboratory (PSL). The results of the study were reported in the *Southwest Regional Spaceport Technical Feasibility Report and Strategic Development Plan* (NMSU 1995). The study concluded that it was economically and technically feasible to develop of a commercial spaceport in the southwest. A major element of the NMSU/PSL feasibility study was the determination of the existence of acceptable sites.

## 1.1 NASA Study Selection Criteria

The NMSU/PSL feasibility study eventually examined a broad spectrum of criteria in the selection of sites recommended for further study. However, the initial criteria considered for a spaceport location were

- population density
- land area availability and accessibility
- orbital access

At the initiation of the study the most recently published safety and risk assessment criteria for a commercial reentry vehicle were those the Department of Transportation (DOT), Office of Commercial Space Transportation (OCST) had published in association with the Commercial Experiment Transporter (COMET) Reentry Vehicle System. The COMET risk assessment criteria were used with the NMSU/PSL developed selection criteria in the first round of screening to determine a spectrum of potential sites.

### 1.1.1 COMET Risk Assessment Criteria

The proposed COMET risk assessment criteria appeared in the *Federal Register* on March 24, 1992 as "The Evaluation Criteria for Issuance of Vehicle Safety Approval for the COMET Reentry Vehicle System" (57 *FR* 10213-10216).

The COMET standard expressed the requirement to satisfy three evaluation criteria. The OCST rationale for selection and the evaluation criteria are discussed in detail in the *Federal Register* notice. The three COMET criteria are listed briefly.

- First, the probability that an off-site landing would not exceed three in 1,000 missions, based on a landing site area defined by a standard deviation (three-sigma) from the designated recovery point.
- Second, the risks to people in the immediate vicinity of the landing site would not be exposed to a greater risk than they would confront daily while performing routine activities. The immediate vicinity was defined as the area within the 100 miles of the designated landing site.
- Third, that additional risks to the general public beyond the 100-mile zone around the designated landing site would not exceed the normal background risks to which they would normally be exposed.

Using the best available technical information on the COMET program (DOT/OCST [personal communication] 1993), the three-sigma landing site area was determined to consist of an ellipse with a major (long) axis of 29.7 miles and a minor (short) axis of 9.9 miles. To meet the second and third criteria, a 100-mile buffer is required around the landing site. The resultant area is an ellipse with a major axis of 230 miles and a minor axis of 210 miles. Although this area is elliptical, for the large scales used in the initial screening, the area is nearly circular. Therefore, for convenience, a circle with a diameter of 230 miles was used in the initial screening process.

### 1.1.2 Population Density

To achieve the required low risk levels, the ratio of the COMET reentry vehicle impact area to the total area of the screening circle was used to determine a maximum permissible population density. The first COMET assessment criteria applies to the landing site itself, the initial three-sigma ellipse. For that area, the maximum permissible population density was established as less than 10 people per square mile. The maximum permissible population density within the larger screening circle was established as approximately 15,000 people per square mile.

The application of this criterion eliminated such metropolitan areas as the Los Angeles-to-Riverside metroplex; Phoenix and Tucson, Arizona; and the El Paso, Texas-Ciudad Juarez, Chihuahua metroplex. Albuquerque, New Mexico, and Amarillo, Texas, were not eliminated by this criteria. The application of the population density criteria for the landing site eliminated most of the area of central and east Texas from consideration.

### 1.1.3 Orbital Access

The second NMSU screening criteria was orbital access. The more widely used equatorial orbits are more accessible, and more economically attained from launch sites in lower latitudes. Requirements under this criteria favored the southern part of the U.S. over sites in Utah and Colorado.

Applying these two basic criteria, NMSU (1995) developed eight potential candidate spaceport location areas in southern California, Arizona, New Mexico. These sites were located in the general geographic vicinity of the following locations:

- Las Vegas, NV
- Kingman, AZ
- Winslow, AZ
- Greenlee County, AZ
- White Sands Missile Range, NM
- Roswell, NM
- Tucumcari, NM
- Carlsbad, NM

### 1.1.4 Land Availability and Accessibility

The land availability and accessibility criteria considered such items as the percentage of public land; the presence and extent of National Parks, Monuments, and other special management areas; and the presence and extent of Native American lands. The application of these criteria eliminated areas such as the Grand Canyon National Park and numerous Native American reservations from consideration as potential sites. The initial locations effected were Greenlee County, Winslow, Kingman and Las Vegas. However, the study was expanded to include consideration of sites extending into the interior of Mexico. The new sites were near the Rio Grande southwest of Van Horn, Texas, and a site located in northern Chihuahua, Mexico.

### 1.1.5 Additional Screening

Additional location constraints and requirements which emerged from the NMSU/PSL study included orbital insertion physics, existing infrastructure, topography and soil characteristics, access to airspace, extent of landing zones, land use and ownership, meteorological conditions, and general environmental considerations. These criteria and other secondary criteria are discussed in detail in the NASA feasibility report (NMSU 1995). A subjective compilation of the results of the initial screening evaluations is shown in Table 1, NASA Study Sites.

### 1.2 Site Location

The NASA Grand study only determined that the sites they examined were technically feasible as spaceport locations. However, the southern New Mexico area adjacent to the western flank of WSMR emerged from this study (NMSU 1995) as the most viable location for a regional commercial spaceport. This location fulfilled the technical citing requirements, and complied with environmental and public safety constraints. The critical combination of access to airspace and orbital insertion physics was satisfied by this location more than by any other location examined in the study.

## 2 WSMR Environmental Siting Study

Although the final NASA feasibility report was not published until 1995, there were two parallel and complementary studies interacting in the site screening process. The first was an environmental site screening study conducted by WSMR under direct Department of the Army funding. This study was published by WSMR in March 1993 as the *Environmental Siting Analysis for the Southwest Regional Spaceport Program* (WSMR 1993).

**Table 1.** NASA Study General Site Characteristics

| | Clear Landing Zones | Land Ownership | Land Availability | Access to Air Space | Infrastructure | Orbital Physics | Topology & Soils | Meteorology | General Environment |
|---|---|---|---|---|---|---|---|---|---|
| Las Vegas, NV | Good | Federal/Native American | Poor/WSAs/ Nat'l. Parks | Poor/Airways | Good | Marginal/ Equatorial | Good | Poor/Heat | Marginal/WSAs |
| Kingman, AZ | Good | Federal/Native American | Poor/WSAs/ Grand Canyon/ Native American Reservations | Marginal/ Military operating areas | Satisfactory/ No air | Marginal/ Equatorial | Good | Good | Poor/Nat'l Parks |
| Winslow, AZ | Good | Federal/Native American | Poor/Native American Reservations | Satisfactory/ Airways | Marginal/No rail or air | Marginal/ Equatorial | Marginal/ Mountains | Good | Good |
| Greenlee Cty, AZ | Marginal/ Mountains | Private/Federal | Poor/Native American Reservations | Satisfactory | Marginal/ Distance to road and rail, no air | Satisfactory | Marginal/ Poor construction conditions | Good | Satisfactory |
| WSMR, NM | Good | Federal/State | Good | Good | Good | Satisfactory | Good | Good | Satisfactory |
| Roswell, NM | Good | Private | Poor/Ownership | Satisfactory/ Military operating areas | Marginal/No air or road | Satisfactory | Good | Satisfactory/ Haze | Marginal/Oil industry pollution |
| Tucumcari, NM | Satisfactory | Private/State | Marginal/ Ownership | Satisfactory | Marginal/No air or rail | Marginal/ Equatorial | Marginal/ Mountains | Marginal/ Adverse winter | Satisfactory |
| Carlsbad, NM | Good | Private/State | Poor/Ownership | Marginal/ Airways | Marginal/No air or road | Marginal/ Down-range population | Good | Poor/Heat | Satisfactory |
| Van Horn, TX | Satisfactory | Private | Poor/Ownership | Good/Int'l traffic unknown | Poor/Isolated | Satisfactory/ Dallas-Fort Worth & Houston limit space station missions | Good | Poor/Heat | Satisfactory |
| Northern Chihuahua, Mexico | Satisfactory | Mexican federal | Unknown | Unknown/ Int'l traffic unknown | Poor/Isolated | Good | Good | Marginal/Haze/ Heat | Unknown |

WSA = Wilderness Study Area

### 2.1 WSMR Study Selection Criteria

In the WSMR study, a literature search using standard environmental assessment attributes was performed for four candidate sites located on the western flank of WSMR. These sites are shown on Figure C-1, Site Selection Candidate Locations. Siting criteria used to select the four sites included

- Availability of approximately 10 square miles of contiguous or State of New Mexico land
- Location within acceptable 40×100-mile "impact area" using sites within WSMR boundaries as the primary landing zones
- Location within five miles of an existing improved road
- Location within 20 miles of the WSMR boundary (but not on WSMR itself)
- Absence of obvious environmental constraints

### 2.2 WSMR Siting Study Results

The WSMR study indicated that Candidate Site A, the southwestern site would be potentially sensitive due to cultural resource considerations. The literature search showed that none of the other candidate sites exhibited obvious environmental flaws.

## 3 U.S. Air Force Grant I Dual Use Launch Facility Study

The NASA grant feasibility study and the WSMR environmental siting study were paralleled by the U. S. Air Force (USAF) Dual Use Launch Facility Grant Program (Grant I). Under this program the USAF competitively awarded several grants to various state/commercial teams for the purpose of conducting feasibility studies for the development of space vehicle launch facilities on a commercial, or joint military and commercial basis. The State of New Mexico developed and submitted a proposal for one of the Grant I studies. The proposal efforts were organized and administered under the Office of the Lieutenant Governor. The proposal combined tasking for personnel from the State, NMSU/PSL, WSMR, and McDonnell Douglas Aerospace.

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**Figure 1**Feasibility Study Site Selection Candidate Locations

New Mexico was awarded one of the USAF grants. To direct and manage the Team organized to carry out the Grant I scope of work, New Mexico passed legislation creating the New Mexico Office for Space Commercialization (NMOSC) in February 1994. The enabling legislation additionally tasked NMOSC with developing and administering a cohesive program to establish a viable commercial spaceport program. The Grant I Team completed the initial study report, *Dual Use Launch Facility Grants Requirements Study* (New Mexico 1995) in April 1995. In addition to the full spectrum of economic viability, feasibility, operational requirements, and facilities requirements studies, the Grant I study defined a specific location for the projected spaceport.

## 3.1 Grant I Site Selection Criteria

The New Mexico (1995) Grant I Team conducting the siting study, as well as the feasibility study, was composed of representatives from NMOSC, WSMR, NMSU/PSL, and two interested aerospace companies. The effort was supported by a commercial engineering firm through a subcontract.

The Grant I Team evaluated the available data and concluded that an area on the western flank of WSMR would provide the most technically feasible locations for the commercial spaceport. The conclusion was based on

- availability of WSMR tracking, communications, and range safety facilities
- orbital physics favoring vehicle launches on easterly azimuths
- access to existing special-use airspace eliminating conflicts with established commercial airways

The Grant I Team initially selected 10 candidate SRS sites for further detailed study. The Grant I locations included potential sites in the immediate vicinity of each of the four potential sites previously examined by WSMR (1993) (Figure C-1).

A weighted, parametric evaluation procedure was developed to determine the relative suitability of each candidate site. The procedure required each evaluator to assign a subjectively determined numerical score for each of 19 evaluation criteria. The individual evaluator's scores were weighted and synthesized into a composite ranking of the sites.

The 19 criteria were divided into two groups, “must haves” (absolutely essential) and “wants” (a siting bonus). The “must have” criteria included

- All flight corridors will meet DOT regulations

- Mitigation of adverse environmental impacts is practical and can be accomplished in a timely and cost-effective manner
- Acquisition of sufficient land area for SRS operations and to meet public safety requirements is feasible
- Adequate control of airspace needed to establish a wide range of flight corridors is possible
- Adequate water supply is available for full SRS development

These criteria were either met or not met. Any potential site not meeting all "must have" criteria was not considered further.

The second group contains those criteria deemed important but which lend themselves to being graded both to their relative importance and the degree to which a given potential site meets each criterion. The criteria used by the Grant I Team were

- Close proximity to power distribution center
- Access to a railroad
- Access to a telephone communications system
- A minimum of a two-lane road connecting to a main highway
- Reasonable distance from a nearby city with existing minimal infrastructure to support spaceport type operations
- Launch and landing at all typical azimuths and inclinations
- Minimal interference to and from WSMR
- Sufficient flight safety buffer zone
- Buffer zone from any area that is adversely effected by propellant venting
- Preclusion of groundwater contamination from potential releases of normal space vehicle related materials
- Preclusion of noise pollution to populated areas
- Sufficient distance for base instrumentation siting
- Main terminal siting minimizes interface with other RF users

## 3.2 Site Survey Findings

A complete description of the site evaluation methodology and the detailed results of the weighted evaluation of each of the ten sites is given in New Mexico (1995). Table 2 provides the total weighted evaluation and the relative ranking of each site, and Table 3 is a subjective compilation of the results of the screening evaluations.

Table 2 Spaceport Site Selection Evaluations

| Site | Weighted Evaluation Score | Rank |
|---|---|---|
| S-1 | 49.8 | 6 |
| S-2 | 44.56 | 8 |
| S-3 | 65.92 | 3 |
| S-4 | 66.6 | 2 |
| S-5 | 69.8 | 1 |
| S-6 | 63.9 | 4 |
| S-7 | 54.85 | 5 |
| S-8 | 42.4 | 10 |
| S-9 | 48.0 | 7 |
| S-10 | 43.4 | 9 |

The methodology used by the Grant I Team should not be construed as an absolute determinant. Rather it was used as a structured tool for distinguishing on a consistent basis between potential sites, allowing the decision making process to focus on potential sites likely to be acceptable while eliminating less favorable potential sites for identifiable

**Table 2.** NMOSC/WSMR Site Screening Criteria

Sites investigated in the Grant I study are keyed to map locations on Figure 2. Site 1-4 are within the proposed SRS boundaries.

| Candidate Site Characteristics | S1/CS-A | S-2 | S-3 | S-4 | S-5 | S-6 | S-7/CS-B | S-8/CS-C | S-9 | S-10/CS-D |
|---|---|---|---|---|---|---|---|---|---|---|
| Existing infrastructure | Adequate | Marginal | Good | Good | Good | Adequate | Adequate | Poor | Adequate | Marginal |
| Proximity to population center | Good | Good | Adequate | Adequate | Adequate | Adequate | Marginal | Marginal | Marginal | Marginal |
| Access to typical launch/ recovery azimuths | Adequate | Adequate | Adequate | Good | Good | Good | Good | Adequate | Poor | Poor |
| Minimal interference with WSMR operations | Adequate | Adequate | Good | Good | Good | Good | Adequate | Adequate | Marginal | Marginal |
| Departure buffer zone | Marginal | Marginal | Adequate | Adequate | Good | Good | Adequate | Adequate | Adequate | Marginal |
| Ecological compatibility | Marginal/ Big horn sheep | — | — | — | — | — | Adequate | Adequate | — | Marginal |
| Cultural resources compatibility | Poor | — | — | — | — | — | Marginal | Marginal | — | Marginal |
| Air quality compatibility | Poor | Poor | Adequate | Adequate | Adequate | Adequate | Adequate | Adequate | Poor | Adequate |
| Water quality compatibility | Poor | Poor | Adequate | Adequate | Adequate | Adequate | Adequate | Adequate | Adequate | Adequate |
| Noise pollution compatibility | Poor | Poor | Adequate | Adequate | Adequate | Adequate | Adequate | Poor/WSA | Poor | Marginal |
| RFR/EMI potential | Marginal | Marginal | Adequate | Adequate | Adequate | Adequate | Marginal | Adequate | Marginal | Adequate |

reasons. The methodology considered broad environmental considerations as well as specific technical considerations. The detailed environmental analyses has been performed in this document.

## 4 SRS Designation

NMOSC initially identified an area of some 500 square miles adjacent to WSMR on the Jornada del Muerto based on

- The evaluations of the various sites using the Grant I Team screening results
- The NASA (1995) study evaluations
- The WSMR (1993) environmental siting analysis

Further consideration by New Mexico executive officials narrowed the scope of the proposed boundaries by stipulating preference for development of State Trust Land.

The resulting SRS area encompasses four of the Grant I Team evaluated sites, including the three with the top parametrial potential for meeting the full nineteen element evaluation criteria. Three of the ten sites examined by the USAF Grant I team, including the site evaluated to have the highest parametric potential (S-5), were eliminated due to non-availability of sufficient public land (S-5 and S-6), and acute adverse topological/geological conditions (S-8). The area also includes buffer areas sufficient to allow any internal engineering adjustments which may be required to compensate for multiple customer facilities, and unanticipated environmental or technical problems.

## 5 Conclusion

The NMOSC Grant I Team study (New Mexico 1995), and the NASA studies (NMSU 1995, WSMR 1993) together evaluated 16 sites in New Mexico. These various SRS site-screening activities resulted in identification by the NMOSC of the area described in Section 2.1.3 of the main document. Information related to the environment siting criteria is included in Section 3.0 of the main document which describes the environment affecting, or to be affected by, SRS construction and operation.